(12) UK Patent Application (19) GB (11) 2 312 963 (13) A

(43) Date of A Publication 12.11.1997

(21) Application No 9704089.3

(22) Date of Filing 27.02.1997

(30) Priority Data
(31) 9605935 (32) 06.05.1996 (33) FR

(51) INT CL[6]
G01R 11/24

(52) UK CL (Edition O)
G1U UR1124

(56) Documents Cited
EP 0455518 A2 EP 0248137 A1 US 5086292 A

(58) Field of Search
UK CL (Edition O) G1U UR1124 UR2100 UR2106 UR21133 , G4V VPBE
INT CL[6] G01R 11/24 21/00 21/06 21/133 , G07F 15/00 15/10
Online: WPI

(71) Applicant(s)
Schneider Electric S.A.

(Incorporated in France)

40 Avenue Andre Morizet,
F-92100 Boulogne-Billancourt, France

(72) Inventor(s)
Alain Gilot

(74) Agent and/or Address for Service
Forrester Ketley & Co
Forrester House, 52 Bounds Green Road, LONDON,
N11 2EY, United Kingdom

(54) Prepayment electrical supply system with means for fraud indication

(57) A prepayment electrical supply system comprises means of detecting the existence of electricity consumption from the time of activating the electrical supply system and means suitable for indicating an anomaly when no electricity consumption is detected. The system also includes means 11 to indicate the presence of voltage. The indication of an anomaly, when no electricity consumption is detected, may be reset when electricity consumption is detected and the means of electricity consumption detection may involve current measuring means. The system may also include means to detect the balance of credit against the value of electricity supplied and if a negative balance occurs or exceeds a certain threshold, a further indication of possible fraud may be provided. The system can detect and indicate by means of a display 8 the possible use of bypass arrangements L3, L4 around the means of measurement 5 and / or the means of isolation 2.

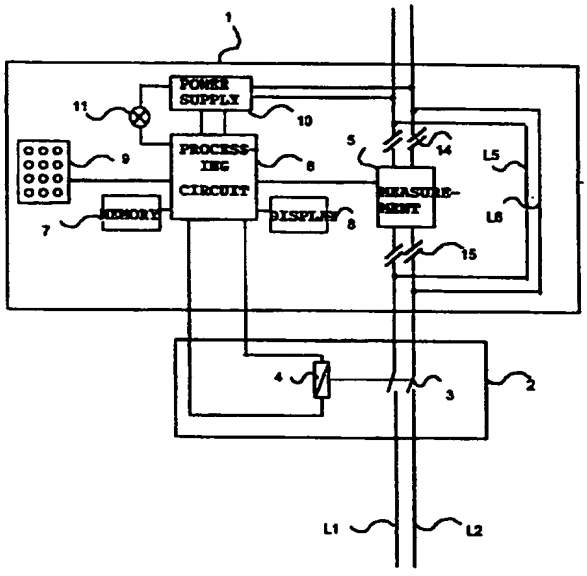

Figure 3.

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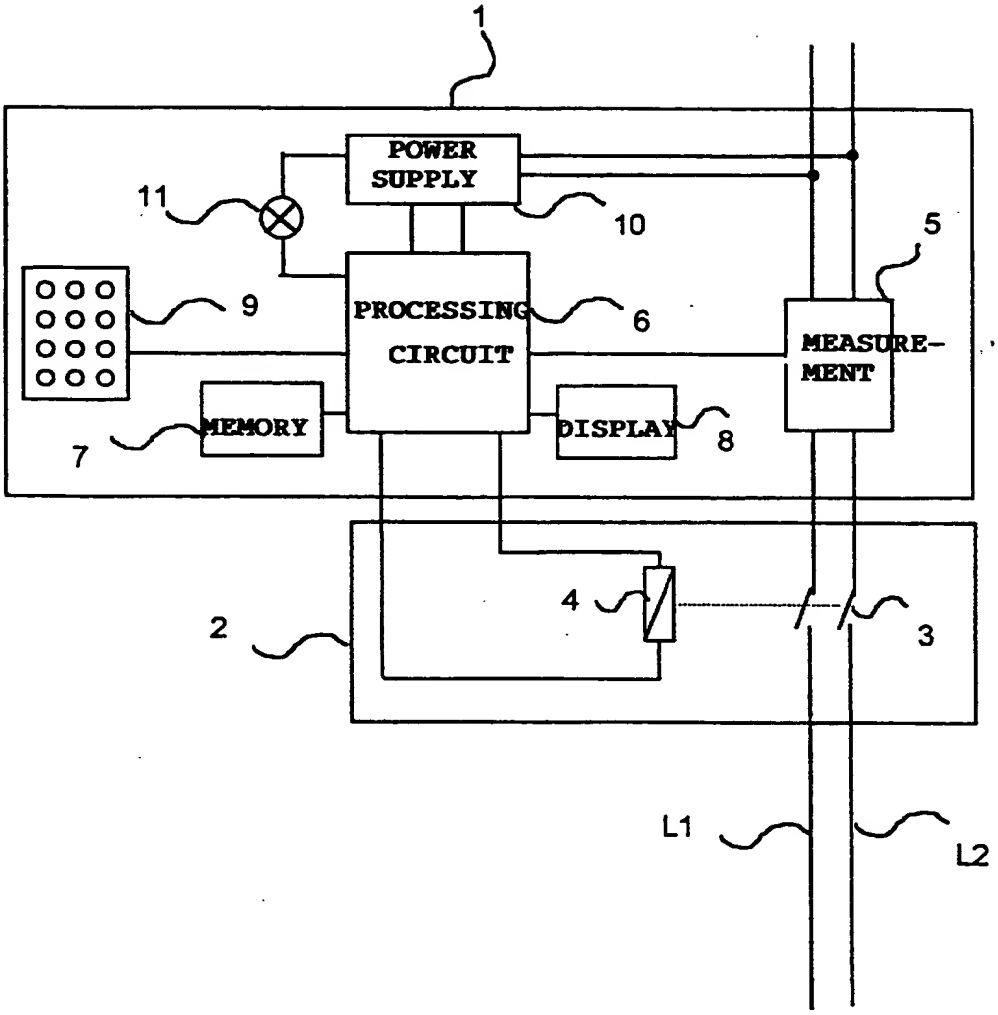

Figure 1 (PRIOR ART)

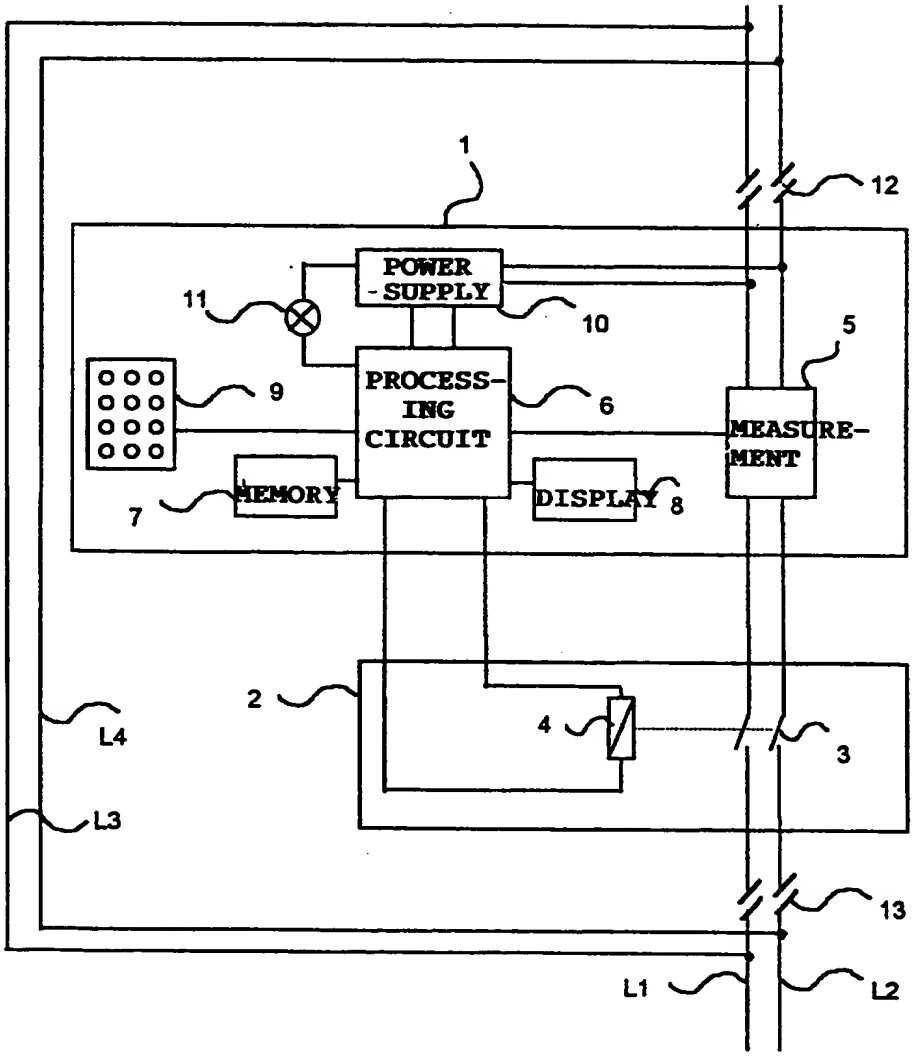
1
12
POWER
-SUPPLY
11
10
5
9
PROCESS-
ING
CIRCUIT
6
MEASURE-
MENT
MEMORY
7
DISPLAY
8
2
4
3
L4
L3
13
L1
L2

Figure 2.

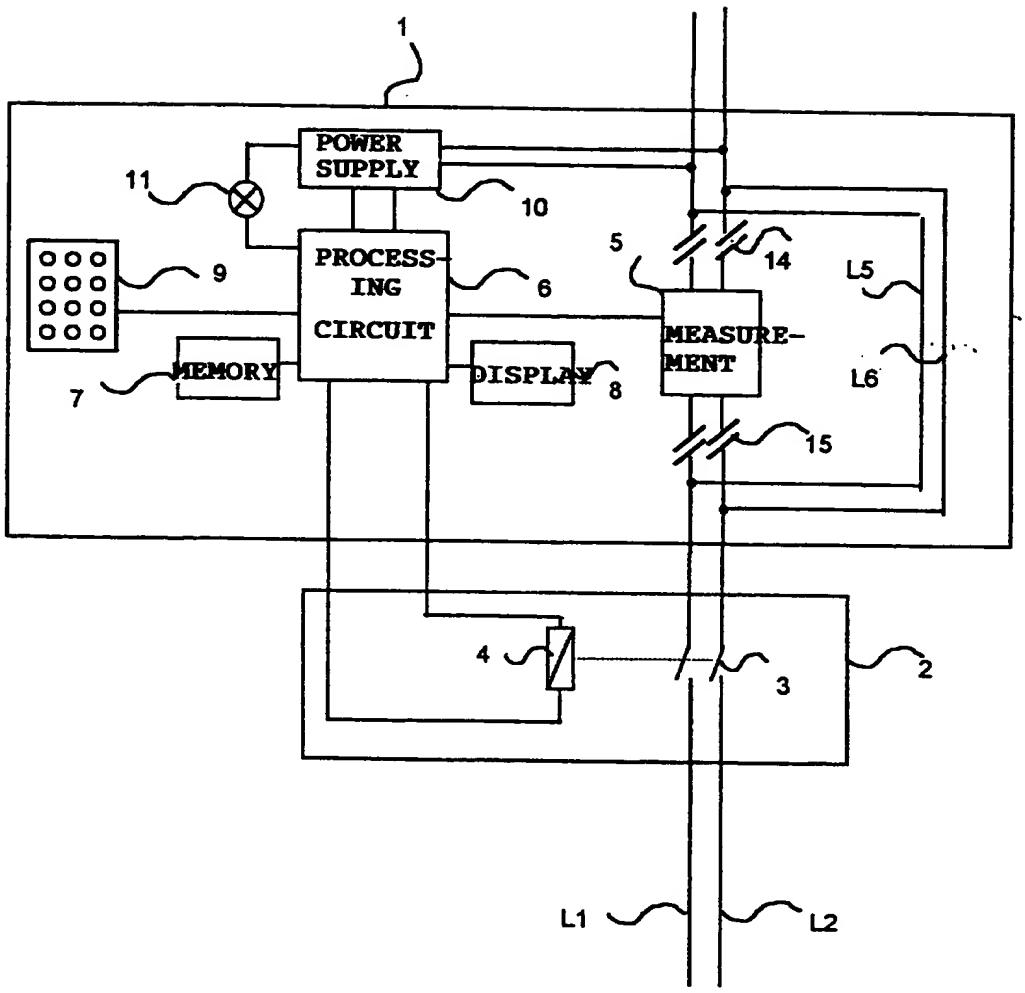
1
POWER SUPPLY
11
10
PROCESS-ING CIRCUIT
9
6
5
14
L5
MEASURE-MENT
L6
MEMORY
7
DISPLAY
8
15
4
3
2
L1
L2

Figure 3.

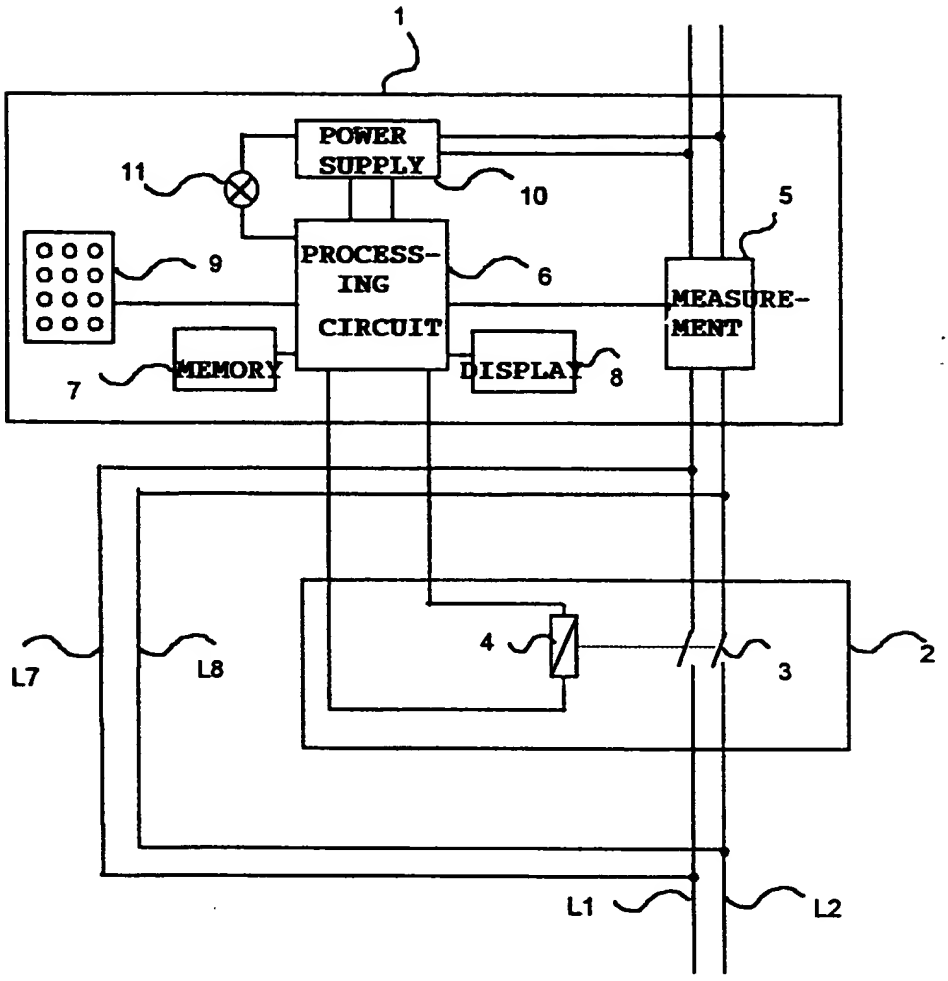
1
POWER SUPPLY
11
10
5
9
PROCESS-ING CIRCUIT
6
MEASURE-MENT
MEMORY
DISPLAY
7
8
4
3
2
L7
L8
L1
L2

Figure 4.

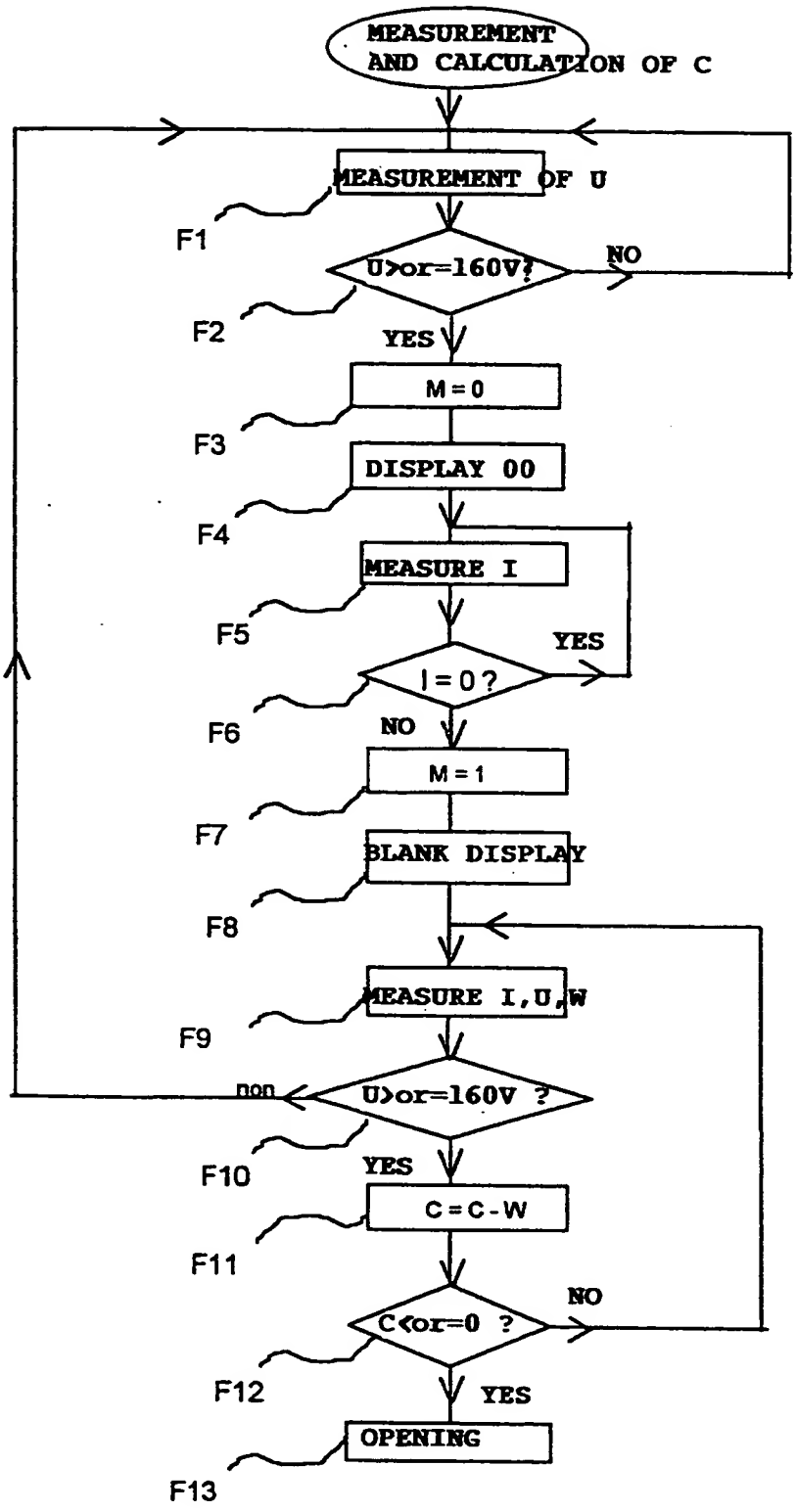
MEASUREMENT AND CALCULATION OF C
MEASUREMENT OF U
F1
U>or=160V?
NO
F2
YES
M=0
F3
DISPLAY 00
F4
MEASURE I
F5
YES
I=0?
F6
NO
M=1
F7
BLANK DISPLAY
F8
MEASURE I,U,W
F9
non
U>or=160V ?
F10
YES
C=C-W
F11
C<or=0 ?
NO
F12
YES
OPENING
F13

Figure 5.

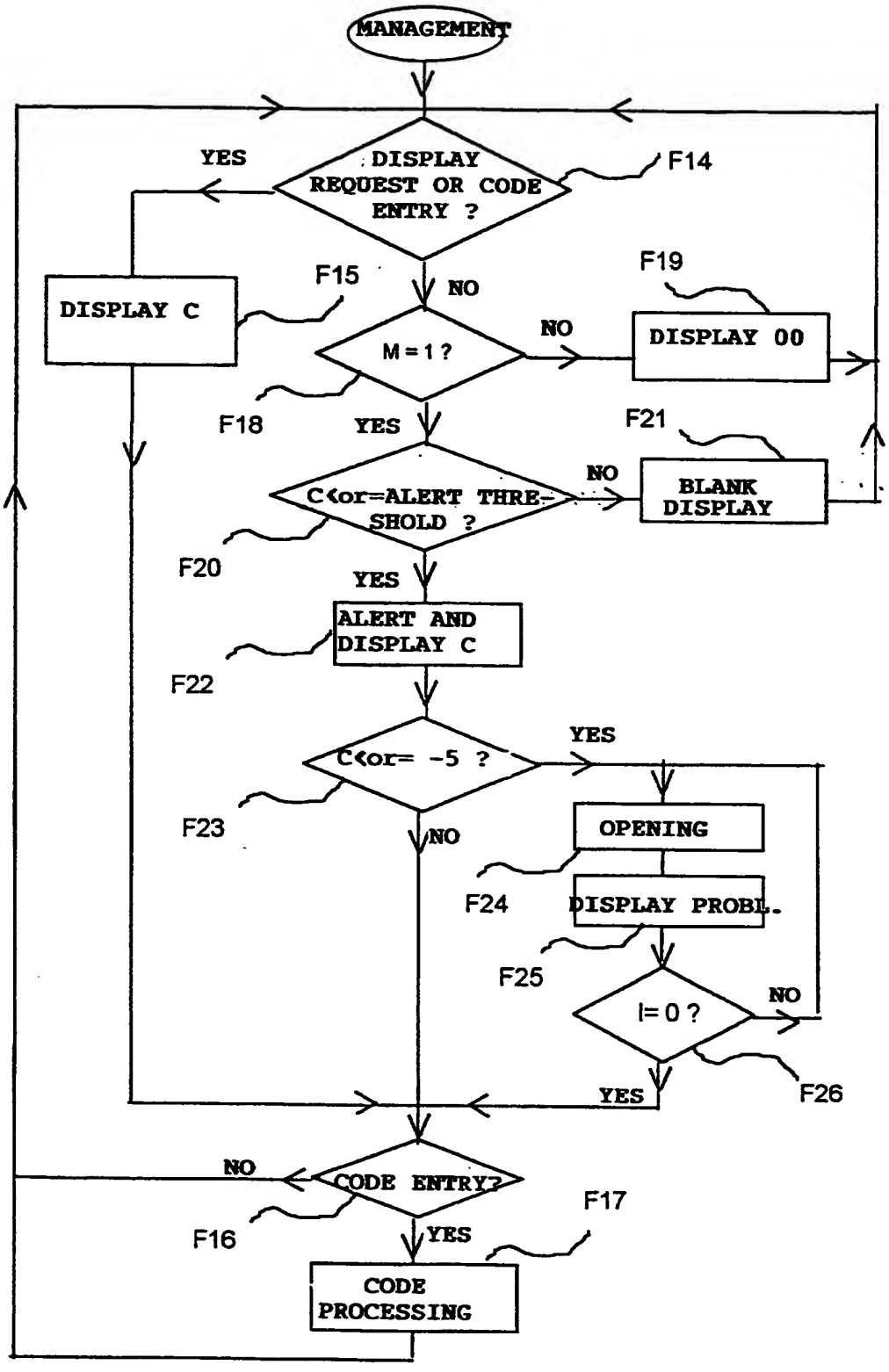
MANAGEMENT
DISPLAY REQUEST OR CODE ENTRY ?
F14
YES
NO
DISPLAY C
F15
M=1?
F19
NO
DISPLAY 00
F18
YES
F21
C<or=ALERT THRESHOLD ?
NO
BLANK DISPLAY
F20
YES
ALERT AND DISPLAY C
F22
C<or= -5 ?
YES
F23
NO
OPENING
F24
DISPLAY PROBL.
F25
I= 0 ?
NO
YES
F26
NO
CODE ENTRY?
F16
YES
F17
CODE PROCESSING

Figure 6.

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ELECTRICITY CONTROL SYSTEM WITH PRE-PAYMENT WITH A FRAUDPROOF DEVICE

The invention relates to an electricity control system with pre-payment comprising electricity management means comprising fraud detection means, said fraud detection means comprising voltage presence indication means.

Electricity control systems with pre-payment are known wherein each user has a management circuit, with a circuit for measuring the power used, connected to a switch or a circuit breaker to interrupt the user's electricity supply when the amount of an electricity credit, stored in the management circuit and reduced as and when electricity is consumed, has been used up. The amount of the credit can be modified by entering a pre-payment code into the management circuit. In known systems, this code is entered either via a keypad or by means of a magnetic card, or by means of an electronic chip token.

In state of the art systems, certain measures have been taken to prevent fraud. It is in particular known to use mechanical fraud prevention devices, for example in the form of seals. Electronic fraud prevention devices, for their part, present the drawback of not operating without electricity, which can make it easier for an unscrupulous user to get round them. Known devices notably comprise a voltage presence diode which is only lit when the management circuit is supplied with electricity. Extinction of the voltage presence diode can therefore easily indicate a fraud consisting in short-circuiting the electricity control system. It is on the other hand insufficient to detect other types of fraud.

The object of the invention is to improve fraud detection in an electricity control system with pre-payment.

According to the invention this object is achieved by the fact that the fraud detection means comprise means for detecting the existence of an electricity consumption as from the time the electricity management means are powered on, and means for indicating an anomaly in its absence.

According to a development of the invention, the electricity management means comprise means for entering and storing an electricity credit, means for measuring

the amount of electricity consumed by a user, means for determining an electricity credit balance according to said electricity credit and to the amount of electricity consumed, the fraud detection means comprising means for detecting a negative electricity credit balance and means for indicating a fraud when said balance is negative.

The means for detecting the existence of an electricity consumption preferably comprise current measuring means.

Thus, the electricity management circuit detects the existence of an electricity consumption after power-up. In the absence of any electricity consumption, an anomaly is indicated designed to draw attention to the likelihood of a fraud consisting in short-circuiting the measuring circuit of the management circuit. The management circuit also checks the possible existence of a negative electricity credit balance. The existence of such a balance is indicated so as to draw attention to the likelihood of a fraud consisting in short-circuiting the breaking contacts of the system.

Other advantages and features will become more clearly apparent from the following description of an illustrative embodiment of the invention given as a non-restrictive example only and represented in the accompanying drawings in which :

Figure 1 represents an electricity control system with pre-payment according to the prior art, in which the invention can be implemented,

Figures 2 to 4 illustrate the different types of fraud able to be detected by a fraud prevention device,

Figures 5 and 6 illustrate particular embodiments of processing flow charts for implementation of the invention in a system according to figure 1.

The electricity control system with pre-payment of figure 1 comprises an electricity management circuit 1 and a switch or circuit breaker 2. The switch 2 comprises contacts 3 fitted on power supply lines L1 and L2 designed to supply electricity to a user. Opening of the contacts 3 is performed by a relay 4 of the switch 2 under the control of the management circuit 1.

The management circuit 1 comprises a measuring circuit 5 connected to a microprocessor-based processing circuit 6. The measuring circuit 5 can comprise current sensors, and possibly voltage sensors, fitted on the lines L1 and L2, the processing circuit 6 then being able to calculate the electricity delivered to the user and the electricity consumed. Alternately, the measuring circuit 5 can comprise an electricity meter of known type disposed in such a way as to measure the electricity supplied to the user by the power supply lines L1 and L2.

In the management circuit 1, the processing circuit 6 is connected to a memory 7, a display circuit 8 and a keypad 9. An electricity credit balance C is stored in the memory 7. The processing circuit 6 decreases the amount of this credit balance according to the amount of electricity used W, the information necessary for measurement and/or calculation of the amount of electricity used being supplied to the processing circuit by the measuring circuit 5. The amount of the stored credit balance can be modified by means of a code entered via the keypad 9 accessible to the user. The display circuit 8 enables the user to be informed of the amount of the stored credit balance, i.e. the remaining electricity credit.

When the amount of the credit balance stored in the management circuit has been used up, the processing circuit 6 operates the relay 4 so that the latter opens the contacts 3, causing the electricity supply to the user by the lines L1 and L2 to be interrupted.

In known devices, an electricity supply circuit 10 connected to the lines L1 and L2 supplies the different components of the management circuit, and also the relay 4 of the switch 2 via the circuit 1. The presence of the system supply voltage is indicated by an indicator lamp 11, preferably formed by a light-emitting diode. This diode is extinguished if the supply voltage is absent and lit when the voltage supplied to the management circuit 1 by the lines L1 and L2 is sufficient. As a non-restrictive example, the voltage presence diode 11 is extinguished when the voltage U between the lines is less than 160V and constantly lit if the voltage U is greater than 160V.

A first type of fraud, illustrated in figure 2, consists in totally short-circuiting the electricity control system which is powered off. To do this, the lines L1 and L2 are interrupted up-line (12) and down-line (13) from the assembly formed by the management circuit 1 and circuit breaker 2. The user's electricity supply is provided

permanently by conductors L3 and L4 respectively connected to the lines L1 and L2 up-line and down-line from the interruptions 12 and 13 of the lines L1 and L2. In this case, the management circuit 1 is no longer supplied and the voltage presence diode 11 is extinguished. Detection of this type of, known, fraud is however insufficient.

A second type of fraud, illustrated in figure 3, is in fact not detected by the voltage presence diode 11. In this case, only the measuring circuit 5 is short-circuited. The lines L1 and L2 are interrupted up-line (14) and down-line (15) from the measuring circuit. The continuity of the lines L1 and L2 is achieved respectively by conductors L5 and L6 connected respectively to the lines L1 and L2 up-line and down-line from the interruptions 14 and 15 of the lines L1 and L2. The electricity supply circuit 10 of the management circuit 1 therefore remains supplied by the lines L1 and L2 and the voltage presence diode 11 remains lit so long as the voltage on the lines L1 and L2 is sufficient. However, as the measuring circuit 5 is disconnected, the measurement of the current and/or power consumed supplied to the processing circuit remains zero and this circuit cannot take the electricity consumed into account. The initial electricity credit is therefore not reduced according to the effective electricity consumption. The management circuit can no longer carry out its function.

A third type of fraud, illustrated in figure 4, is not detected by the voltage presence diode 11 either. In this case, only the circuit breaker 2 is short-circuited, by conductors L7 and L8 connected respectively to the lines L1 and L2 up-line and down-line from the circuit breaker 2. The management circuit 1 continues operating normally. It is in fact supplied with electricity and measures the electricity consumed by the user in the normal manner. The voltage presence diode 11 is normally lit. However, an order to open the contacts 3 of the circuit breaker 2 does not interrupt the user's electricity supply, which continues to be performed via the conductors L7, L8.

The particular embodiment represented in figures 5 and 6 enables the second and third type of fraud to be indicated.

As represented in the flow chart of figure 5, a routine for power measurement and calculation of the electricity credit balance C comprises a first stage F1 of measurement of the voltage U between the lines L1 and L2, i.e. of the voltage between phase and neutral for the single-phase power system represented in figures 1 to 4. Then, in a stage F2, the voltage U is compared to a threshold. In figure 5, this

threshold is 160V. If U is lower than this threshold, the power supply is considered to be insufficient and the processing circuit loops back to the stage F1. When U reaches this threshold, the processing circuit goes on to a stage F3 in which a quantity M is set to a first value, 0 in figure 5. Then, in a stage F4, the message 00 is displayed. Then in a stage F5, the processing circuit measures the current I which is supplied to it by the measuring circuit 5. In a stage F6 it checks whether the current I is zero. If this is the case, it loops back to the stage F5. In this way the display remains 00 so long as, the voltage U being sufficient, there is no electricity consumption by the user since the last power-up of the electricity management circuit 1.

On the other hand, as soon as a current I which is not zero is detected (NO output of stage F6), the processing circuit goes on to a stage F7 where the quantity M is set to another value, 1 in figure 5. The display is then cleared (blank display) in a stage F8, thus eliminating the anomaly message 00.

Then the processing circuit goes on to a stage F9 of measurement of the current I, the voltage U and the power consumed W between two measurement cycles.

In a stage F10, identical to the stage F2, U is again compared to 160V. If U is insufficient, the processing circuit goes back to stage F1. If on the other hand U remains sufficient, it goes on to a stage F11 in which the balance C is updated, the amount of the balance C being reduced from the amount W of the power consumed. The processing circuit 6 then checks, in a stage F12, if the credit balance C remains positive. If the amount of the credit balance C is negative or zero ($C \leqslant 0$), the processing circuit then proceeds to open the contacts 3 of the switch during a stage F13. To do this, the processing circuit 6 orders excitation of the relay 4 which opens the contacts 3. To supply his installation again, the user has to reclose the switch 2 manually. However, any closing of the contacts before a new electricity credit, which must not be zero, is entered in the management circuit 1 by means of a credit code, automatically leads to the contacts 3 opening again.

If the balance C is positive, the processing circuit goes back to the stage F9 of measuring I, U and W.

In parallel with the electricity measurement and credit balance C calculation program, the processing circuit performs electricity management according to the flow chart represented in figure 6.

In the particular embodiment represented, a management cycle begins with a stage F14 during which the processing circuit checks if a display has been requested by the user or if a code has been entered. In practice, the display request and the beginning of a code entry can be achieved using an identical predetermined key of the keypad 9. Actuating this key will have the same consequences at this level of the flow chart. In case of a display request or a code entry, the processing circuit then proceeds, in a stage F15, with display of the credit balance C. This display is preferably in alphanumerical form, the balance being expressed in KWH or in predetermined units corresponding to the units used when purchasing an electricity credit token.

After the stage F15, the processing circuit 6 checks, in a stage F16, if a code has been entered. If this is the case, it processes this code, in a known manner, in a stage F17 before going back to stage F14, at the beginning of the management cycle. Likewise, if no code is entered at F16, the processing circuit loops back to stage F14.

If, at F14, the processing circuit does not detect either a display request or a code entry, it goes on to a stage F18 during which it checks if the quantity M is at 1. This involves detecting the existence of an electricity consumption after the electricity management circuit 1 has been powered up, by detecting a current which is not zero at any time from the time of power-up. If there has been no electricity consumption since this power-up (M = 0), the processing circuit goes on to an anomaly indication stage F19. In the particular embodiment represented in figure 6, this indication is made in the form of display by the display circuit 8 of the anomaly message constituted by the alphanumerical message 00. The processing circuit then goes back to stage F14.

In this way, so long as no electricity consumption is detected after the management circuit has been powered up, the management routine continuously displays the anomaly signal (F19), except, provisionally, when display of the credit balance C is requested (F14, F15) or when a code is entered (F14 to F17). It is thus possible to

detect the second type of fraud illustrated in figure 3 at the first repower-up of the management circuit 1.

The measuring circuit being short-circuited, no electricity consumption is measured and the electricity credit balance C does not decrease. Due to checking (F18) of the existence of an electricity consumption (M = 1) from the time the management circuit is powered up, the invention enables the existence of an anomaly to be indicated.

However, the lack of electricity consumption (M = 0) during a certain time after power-up does not necessarily mean that the system has been tampered with. It is in fact possible that the user does not use his electrical installation for a certain time. It is therefore scheduled to clear the anomaly message as soon as an electricity consumption is detected (at F6) after the electricity supply has been powered up. In addition, before using his installation, the user can nevertheless proceed with a code entry or request display of C. Display of the anomaly 00 is then cleared momentarily. The stage F18 enables the state of M to be checked. When at stage F18, M = 1, the processing circuit goes on to a stage F20 comparing the electricity credit balance C with a preset alert threshold. If C is greater than this threshold, the processing circuit goes on to a stage F21 in which the anomaly message is cleared. In practice, the display then preferably remains blank. Then the processing circuit goes back to the beginning of the management cycle.

If the credit balance C is less than or equal to the alert threshold, an alert phase F22 comprising display of the credit balance C is performed. Then, at F23, the credit balance C is compared to a negative or zero threshold. If C is greater than this new threshold, then the processing circuit goes to stage F16. In the opposite case, this means that the contacts 3 have not been opened when the electricity credit was used up which should have been detected at F12 by the routine for measurement and calculation of C which runs in parallel. The processing circuit then goes on to an opening stage F24, followed by a fraud indication stage F25. In figure 6, this indication is performed by display of a particular message PROBL. This message should draw attention to the existence of a problem. If the contacts which are not short-circuited open, then the user's electricity supply is interrupted and the measured current is cancelled. In a stage F26, the processing circuit checks correct opening of the contacts. If the contacts are open, the circuit loops back to stage F16, then returns, possibly after a stage F17 to the beginning of the management cycle. If a

credit code was entered, C will normally be greater than the alert threshold (NO output of F16) and display of the PROBL message will be cleared. If a new credit has not been entered, the program will go back to the alert and display of C stage F22 and the PROBL message will also have been cleared.

If on the other hand the contacts 3 are short-circuited as represented in figure 4, opening of the contacts does not prevent the user from being supplied with electricity. The management circuit 1, operating correctly, detects this fraud at the stage F26 since the measured current I is not cancelled. It then loops back to the stage F24 and continues to display the PROBL message.

It is preferable that the comparison threshold used in the stage F23 be negative rather than zero to prevent nuisance display of the PROBL message, for example to take account of the electricity consumption during the period separating the decision to open the contacts from the actual opening of these contacts. In the embodiment represented this threshold is -5 electricity units.

The management circuit will deduct a negative credit from a new electricity credit entered subsequently by means of a credit code.

The particular embodiment represented in the figures thus enables the three following types of fraud to be detected :

- shunting the whole management circuit and the circuit breaker (figure 2). In this case, the fraud is indicated by extinction of the voltage presence diode 11.
- shunting the measuring circuit 5 of the management circuit (figure 3). This fraud, performed with the electricity off, is detected (F18) by the fact that no consumption is detected by the management circuit when the latter is repowered on. The fraud is indicated by an anomaly message 00 (F19).
- shunting the circuit breaker only, the management circuit remaining normally supplied and measuring the electricity consumed correctly. The credit balance going to a negative value is indicated by a PROBL message (F25).

Thus, any attempted fraud with the electricity off is indicated electronically as soon as the electricity is switched back on. When the display means is located outside the user's premises, i.e. accessible to an inspector, display of these messages enables

the inspector to detect an attempted fraud. If the display is located on the user's premises, in a location not accessible to an inspector, it can then be arranged to transmit these messages to an external control centre. This can for example be performed by means of carrier current or by radio waves.

In the embodiment represented in the figures, the electrical power system is single-phase. The invention applies in the same way to a three-phase power system. In this case, the voltage U corresponds to the voltage between each phase and neutral and it is preferably considered as being sufficient if the voltage between at least two phases and neutral is greater than the chosen threshold.

CLAIMS

1. An electricity control system with pre-payment comprising electricity management means (1) comprising fraud detection means, said fraud detection means comprising voltage presence indication means (11), a system characterized in that the fraud detection means comprise means (F6, F7, F18) for detecting the existence of an electricity consumption as from the time the electricity management means (1) are powered on, and means (8, F19) for indicating an anomaly in its absence.

2. The system according to claim 1, characterized in that the means for detecting the existence of an electricity consumption comprise current measuring means (5).

3. The system according to either one of the claims 1 and 2, characterized in that the electricity management means comprises means (F8, F21) for extinguishing the anomaly indication means when an electricity consumption is detected.

4. The system according to any one of the claims 1 to 3, characterized in that the electricity management means comprise means (7, 9) for entering and storing an electricity credit, means (5, F9) for measuring the amount of electricity (W) consumed by a user, means (F11) for determining an electricity credit balance (C) according to said electricity credit and to the amount of electricity consumed, the fraud detection means comprising means (F23) for detecting a negative electricity credit balance and means (F25) for indicating a fraud when said balance is negative.

5. The system according to any claim 4, characterized in that the means (F23) for detecting a negative electricity credit balance comprise means for comparing the electricity credit balance and a preset negative threshold.

6. An electricity control system with prepayment comprising electricity management means substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

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Application No:	GB 9704089.3	**Examiner:**	John Watt
Claims searched:	1 - 6	**Date of search:**	29 April 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G1U (UR1124, UR2100, UR2106, UR21133); G4V (VPBE)

Int Cl (Ed.6): G01R 11/24, 21/00, 21/06, 21/133; G07F 15/00, 15/10

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	EP 0455518 A2	(POLYMETERS) see figures 1 - 3 and column 1, line 1 - column 2, line 30 and column 4, lines 28 - 31	1, 2
Y	EP 0248137 A1	(SANGAMO) see page 17, lines 10 - 27	1, 2
Y	US 5086292	(IRIS SYSTEMS) see column 6, lines 53 - 65	1, 2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.